## REMARKS

In the Office Action dated April 4, 2006, claims 1, 44 and 47 were provisionally rejected under the judicially created doctrine of obviousness-type double patenting as being unpatentable over claims 1, 10 and 27 of copending Application No. 11/093,077. Claims 1-6, 9-11, 13-16, 18-21, 44, 46-54 and 56-58 were rejected under 35 U.S.C. § 103(a) as being unpatentable over U.S. Patent No. 5,327,955 of Easwaran in view of Japanese Patent Document No. JP 59156566 (Japanese '566) and further in view of U.S. Patent No. 4,971,134 of Kawaguchi et al. (Kawaguchi). Claims 17 and 55 were rejected under 35 U.S.C. § 103(a) as being unpatentable over Easwaran, Japanese '566 and Kawaguchi in further view of U.S. Patent No. 5,915,452 of Conroy et al. (Conroy). Finally, claims 22 and 45 were rejected as being unpatentable over Easwaran, Japanese '566 and Kawaguchi in further view of U.S. Patent No. 2,968,848 of Carter. For the reasons outlined in detail below, it is respectfully submitted that the pending claims are in condition for allowance over the art of record.

### Double Patenting

In paragraph 9 of the Office Action, it was stated that claims 1, 44 and 47 were provisionally rejected under the judicially created doctrine of obviousness type double patenting as being unpatentable over claims 1, 10 and 27 of co-pending application Serial No. 11/093,077. As noted, this is only a provisional double patenting rejection because the conflicting claims have not in fact been patented. If it turns out that the '077 application is considered allowable over the prior art before the instant application, applicants will then proceed to file a terminal disclaimer concerning the instant application.

### Independent Claim 1 and Dependent Claims 2-6, 9-11 and 13-22

In the Office Action, claims 1-6, 9-11, 13-16 and 18-21 were rejected under 35 U.S.C. § 103(a) as being unpatentable over Easwaran in view of Japanese '566 and Kawaguchi. It was stated that Easwaran teaches the claimed process for the lost pattern casting of metal comprising the use of forming a shell mold and forming a polystyrene foam pattern with the use of gates and risers and forming an aggregate

coating on the pattern; and an aggregate backing around the coated pattern, wherein the backing is contained in a container or flask, wherein the pattern is either removed before or simultaneously with the delivering of molten metal into the mold; and performing combined heat treatment, including water jet cleaning.

It was admitted that Easwaran fails to teach the use of forming a partially solidified metal casting and removing the mold. Japanese '566 was said to substantially teach the use of simultaneous molten metal pouring and forming a partially solidified metal casting, including a solidified metal shell by using controlled mist-like cooling water spraying on the mold containing molten metal for the purpose of forming a fine grain solidified metal shell and reducing defect for the casting. Kawaguchi was said to teach the use of removing the mold after a solidified metal shell in the mold is formed and strong enough to contain the rest of the molten metal but before the molten metal contained in the shell has been completely solidified for the purpose of reducing casting defects, such as thermal cracking, and minimizing adhesion between the casting product and the mold surface. It was then stated that it would have been obvious to one having ordinary skill in the art to provide Easwaran the use of forming a partially solidified metal casting and the use of removing a mold as taught by Japanese '566 and Kawaguchi in order to further improve the quality of the casting and to reduce defects. This rejection is respectfully traversed.

Easwaran teaches that a solidifying metal should be held at an elevated temperature, usually from 800° to 1650° F (see column 5, line 62) for an extended period of time, typically from 10 to 15 minutes (see column 3, line 64) before the casting is removed. Thus, what is removed is an "as cast" metal part (see column 6, line 5). In the first example in Easwaran, steel is held for 15 minutes at 1600°F before the shell is removed by shot blasting (see column 6, lines 41-44). Similarly, in example 2, the steel casting is held at 1650°F for 15 minutes before a water jet is applied to it. In example 3, a ductile iron casting is maintained at a temperature of 1000°F for 10 minutes and then is air cooled prior to blasting to remove a ceramic shell (see column 7, lines 39-41). Finally, in example 4, a frozen aluminum casting is held at 900°F for 10 minutes before being transferred to a water jet cleaning system.

In all of these examples, Easwaran fully solidifies the molten metal into a casting before removing at least a part of the mold. Thus, Easwaran fails to teach a process for

the lost pattern casting of metals including cooling the molten metal such that it only partially solidifies into a casting and removing at least a part of the mold with a solvent while the casting is partially solidified.

Reference is made in the Office Action to Japanese '566 for its teaching of the use of rapid cooling. However, the Japanese '566 document specifically discloses a metal mold, not an aggregate mold comprising a particulate material and a binder as recited in claim 1. Note Figure 5 of the Japanese '566 document, wherein a metal cross section mold is shown. Figure 4 similarly shows a metal cross section.

The mold disclosed in the Japanese '566 document is referred to as a "permanent mold". It is common for such permanent molds to be opened prior to complete solidification of the casting. The disclosure of such a mold in the Japanese '566 document is not remarkable, since the early opening of such molds is advantageous in order to achieve better productivity for a casting. Enclosed herewith please find a declaration by co-inventor Professor Campbell concerning the Japanese '566 document, as well as other documents cited in a related application, Serial No. 10/614,601, which is also pending before the Examiner.

Also, in Kawaguchi, a metal mold is evident from numerous figures, such as Figures 3, 11, 12, 19, 24, 27-32, 35-38, 40-42, 47, 49, 50 and 52-54. In each figure, a metal cross section is shown. Moreover, Kawaguchi states that their mold 1 is formed from a copper chromium alloy (see column 10, lines 11-13; column 13, lines 8-9; column 16, lines 49-50; column 20, lines 1-2; or, copper or copper alloy, see claims 3, 11, 15, 22 and 24). Thus, Kawaguchi also teaches a permanent mold.

As Professor Campbell notes in his declaration, in the case of metal molds, such as those shown in Kawaguchi and the Japanese '566 document, including mold types referred to as permanent molds, it is common for the mold to be open prior to complete solidification of the casting. This is widely known, perfectly well understood and practiced in permanent mold foundries and die casting shops all over the world. Therefore, the disclosure of such a mold in the Kawaguchi patent or Japanese '566 is not remarkable (see paragraph 6 of the Campbell declaration). Professor Campbell notes that the early opening of the mold is advantageous in order to achieve better productivity for a casting (see paragraph 7 of the Campbell declaration).

However, neither of the two newly applied references, namely, Japanese '566

and Kawaguchi, pertain to aggregate molds. As Professor Campbell states, he is unaware of any method for removing an aggregate mold while the casting is still at least partially molten. He notes that such a practice would probably be dangerous because the lower temperature gradient, and as a result, the less severe cooling that occurs in an aggregate mold as opposed to a metal mold means that the casting which is being molded does not build up as effective a solidified shell as it does in a metal mold. In fact, for many alloys, particularly many non-ferrous base alloys that have high thermal conductivity, the temperature gradient in the casting is so low that liquid can remain at the casting surface until the final moments of solidification. As he notes, it would thus be unthinkable for the mold to be removed prematurely, i.e., prior to complete solidification.

In contrast, it is only complete solidification which is taught in the Easwaran patent. Thus, it would not have been obvious to one having ordinary skill in the art to have replaced the aggregate mold in Easwaran with the metal mold in Japanese '566 or Kawaguchi or to have begun removal of the Easwaran aggregate mold as a result of the teachings in Japanese '566 for Kawaguchi, since they merely pertain to permanent metal molds. There is no motivation for combining Japanese '566 and Kawaguchi with Easwaran in such a way as to remove at least a part of the Easwaran mold prior to complete solidification of the molten metal in the mold into a casting -- which is explicitly taught in Easwaran. As noted in Professor Campbell's declaration, it would be unthinkable in the case of aggregate molds for even part of the aggregate mold to be removed prior to complete solidification of the molten metal into a casting.

The Japanese '566 and Kawaguchi patents do not teach a process for the lost pattern casting of metals comprising removing at least a part of the mold with the solvent while the casting is partially solidified, as recited in claim 1. While Japanese '566 and Kawaguchi do disclose the removal of at least part of the mold while the casting is partially solidified, such removal is not done with a solvent as the molds are metal molds or permanent molds which are merely physically separated away from the casting. While Easwaran does teach an aggregate mold, in Easwaran, the mold is removed only after the casting has completely solidified as pointed out in detail above.

It is respectfully submitted that the only motivation for combining Easwaran with Japanese '566 and Kawaguchi resides in applicants' own claims and specification.

However, the use of applicants' own claims to provide the motivation to combine disparate references, such as Easwaran on the one hand and Japanese '566 and Kawaguchi on the other hand, is not permitted. Therefore, it is respectfully submitted that independent claim 1 is patentable over the applied references of Easwaran, Japanese '566 and Kawaguchi, as well as the remainder of the cited art.

Dependent claims 2-6, 9-11, 13-16 and 18-21 merely further patentably define the detailed subject matter of their parent claim, or each other. As such, these claims are also believed to be in condition for allowance, for the reasons detailed above.

Dependent claim 17 was rejected under 35 U.S.C. § 103 as being unpatentable over Easwaran, Japanese '566 and Kawaguchi, in further view of Conroy. It was stated in this regard that the combination of Easwaran, Japanese '566 and Kawaguchi fails to teach the use of controlling the flow rate and pressure of fluid. Conroy was said to teach the use of nozzles 20 and flow rate and pressure of fluid including water and surfactant for the purpose of removing cores from castings. It was then asserted that it would have been obvious to one having ordinary skill in the art to provide Easwaran, in view of Japanese '566 and Kawaguchi, the use of flow rate and pressure of fluid as taught by Conroy in order to control cooling of the casting in the molten state and remove or crack the water soluble mold from the casting.

In Conroy, the teaching is to the removal of ceramic cores from turbine blade investment castings (see column 3, lines 24-26). In Conroy, the castings have completely solidified. Note the use of fixtures or clamps 12 to hold the blade castings 10 in place. Moreover, attention is directed to claim 1 of Conroy which states in relevant part "apparatus for removing a ceramic core from a metal casting SOLIDIFIED ABOUT said core" (emphasis added). Similarly, independent claim 11 of Conroy recites "apparatus for removing a ceramic core from a metallic turbine blade or vane casting SOLIDIFED ABOUT said core" (emphasis added). Therefore, Conroy does not contemplate that one could remove at least a part of a mold with a solvent while the casting is partially solidified. Accordingly, there is no teaching or disclosure in even the applied four-way combination of the process recited in claim 17. As a result, claim 17 is also patentable, both over the applied four-way combination of references, as well as the remainder of the cited art.

Claim 22 was rejected under 35 U.S.C. § 103 as being unpatentable over

Easwaran in view of Japanese '566 and Kawaguchi and in further view of Carter. In this connection, it was stated that Easwaran, in view of Japanese '566 and Kawaguchi, fails to teach the use of rapid cooling of the molten metal including lowering the mold into a solvent bath. It was stated that Carter teaches the use of rapid cooling, such as simultaneous molten metal pouring and immersion cooling for the purpose of forming a fine grain and reducing oxidation pitting for the casting. It was then stated that it would have been obvious to one having ordinary skill in the art to provide Easwaran in view of Japanese '566 and Kawaguchi, the use of rapid cooling of the molten metal, including lowering the mold into a solvent bath as taught by Carter in order to reduce cycle time of the casting and refine the cast grain size by partially removing water cooled mold parts of the water dispersible mold.

Carter particularly teaches the immersion of its shell mold 20 into its bath 22 "until the molten metal therein solidifies and, preferably, for some time interval thereafter" since this "is important in the practice of the invention" (see column 3, lines 48-51). Carter particularly teaches that his shell "must be self-supporting in the sense that it can be moved into the liquid coolant (see column 4, lines 32-24). Carter further teaches that his poured mold, with the metal in it still in a fluid condition, should be immersed in the body of liquid 22 and that it should be maintained in the liquid until the molten metal solidifies (see column 3, lines 26-27). The purpose given in Carter for immersing molten metal held in a mold in a liquid bath is that the bath has very high heat transfer properties. Carter particularly notes that the liquid used as a coolant "acts essentially to conduct heat away from the mold and establish a controlled cooling rate" (see column 2, lines 61-63). Thus, cooling in Carter takes place through the mold.

There is no teaching in Carter that the mold is or could be removed during the process of solidifying the molten metal into a casting. Carter fails to teach the step of removing at least a part of the mold with a solvent while the casting is partially solidified, as recited in claim 22. In Carter, there is no solvent used to remove the mold. The only teaching of removing at least a part of a mold with a solvent is in Easwaran. However, in Easwaran, the casting is completely solidified before the mold is removed. Moreover, as noted above in connection with independent claim 1, there is no motivation to combine either of Easwaran and Carter with Japanese '566 or Kawaguchi in the absence of applicants' own disclosure and claims. However, the use of the instant

application to provide the motivation to combine the four asserted references is not permitted. Accordingly, it is respectfully submitted that claim 22 also patentably defines over the applied four-way combination of references, as well as the remainder of the cited art.

**Independent Claim 44 and Dependent Claims 45 and 46**

Independent claim 44 and dependent claim 46 were rejected as being unpatentable over Easwaran in view of Japanese '566 and in further view of Kawaguchi. In this connection, claim 44 recites a process for the lost pattern casting of metals comprising the steps of cooling the molten metal such that it partially solidifies to form a partially solidified casting; contacting the backing and the mold with the solvent to decompose at least a part of the backing and at least a part of the mold and contacting the casting with solvent to further solidify the casting. As noted previously, in Easwaran, the casting is completely solidified before the mold is removed. It is true that in Japanese '566 and Kawaguchi, which refer to permanent molds, the molds are removed prior to complete solidification of the casting. However, the Japanese '566 and Kawaguchi molds are not decomposed with a solvent while the molten metal is partially solidified. It is apparent to one of average skill in the art that metal molds, such as those taught in Japanese '566 and Kawaguchi, are not decomposed with a solvent. Rather, they are merely displaced away from the casting.

Moreover, the only motivation for combining Easwaran with Japanese '566 and Kawaguchi is found in the instant application. But, the instant application cannot be used to provide the motivation to combine Easwaran with Japanese '566 and Kawaguchi to render unpatentable pending claim 44. Therefore, it is respectfully submitted that this claim is in patentable condition over the applied three-way combination, as well as the remainder of the cited art.

Dependent claim 46 merely further patentably defines the detailed subject matter of its parent claim. As such, this claim is also believed to be in condition for allowance over the art of record.

Claim 45 was rejected as being unpatentable over Easwaran in view of Japanese '566 and Kawaguchi and in further view of Carter. Claim 45 recites that the steps of contacting the backing with a solvent to decompose at least a part of the

backing and cooling the molten metal such that it at least partially solidifies to form a partially solidified casting are performed by lowering the mold into a bath of the solvent. While it is true that Carter lowers his mold into a bath of solvent in order to solidify the molten metal held in the mold, there is no teaching or disclosure in Carter of decomposing at least a part of the backing while the molten metal is only partially solidified. Rather, in Carter, the casting is completely solidified before any thought is given to removal of the shell mold 20 in which the casting is held. Accordingly, it is respectfully submitted that claim 45 patentably defines over the four-way combination of Easwaran, Japanese '566, Kawaguchi and Carter.

**Independent Claim 47 and Dependent Claims 48-58**

Independent claim 47 and dependent claims 48-54 and 56-58 were rejected under 35 U.S.C. § 103(a) as being unpatentable over Easwaran in view of Japanese '566 and in further view of Kawaguchi. Claim 47 recites a process for the lost pattern casting of metals comprising directing a fluid stream at the mold when the casting in the mold is partially solidified and dislodging at least a portion of the mold, including at least a portion of the particulate material, from the casting while the casting remains only partially solidified. As noted above, Japanese '566 and Kawaguchi both teach permanent molds, i.e., metal molds which are not dislodged by use of a fluid stream. Rather, in both of these patent documents, the permanent molds are simply spaced away by suitable mechanical means from the castings which they enclose. In Easwaran, on the other hand, the mold is completely solidified before any thought is given to removal of the mold, as noted above. Moreover, as also noted above, there is no motivation to combine Easwaran and its particulate mold with Japanese '566 and Kawaguchi and their permanent metal molds, absent the teaching contained in the instant application. However, the use of applicant's own teachings to provide the motivation to combine the prior art references suggested in the Office Action is not allowed. Therefore, claim 47 is patentable over the applied three-way combination of references, as well as the remainder of the cited art.

Dependent claims 48-54 and 56-58 merely further patentably define the detailed subject matter of their parent claim or each other. As such, these claims are also believed to be in condition for allowance over the art of record.

Dependent claim 55 was rejected over a four-way combination of Easwaran, Japanese '566, Kawaguchi and Conroy. However, Conroy does not supply the teachings which are absent from the three way combination of Easwaran, Japanese '566 and Kawaguchi. More particularly, Conroy pertains to an apparatus for removing a ceramic core only after the metallic casting has already solidified about the core. This has been discussed at length above. Accordingly, it is respectfully submitted that even the applied four-way combination of references neither teaches nor discloses the invention recited in claim 55. Accordingly, claim 55 is also in condition for allowance over the applied four-way combination of references, as well as the remainder of the cited art.

**Dependent Claim 59**

Applicant takes this opportunity to add dependent claim 59 which depends from claim 47. Claim 59 recites that the process of claim 47 further comprises continuing to solidify the casting. There is no teaching or disclosure of the subject matter of claim 59 in the applied references of Easwaran, Japanese '566, Kawaguchi, Conroy or Carter or any of the remaining cited art. Therefore, claim 59 is also believed to be in condition for allowance over the art of record.

**Independent Claim 60 and Dependent Claim 61-71**

Applicant takes this opportunity to submit new independent claim 60. Claim 60 recites a process for the lost pattern casting of metals comprising forming a pattern from a material and forming an erodable coating around at least a portion of the pattern to form a mold, the casting comprising a particulate material and a binder. Molten metal is delivered to the mold and a fluid stream is directed at the mold when a casting in the mold is only partially solidified. At least a portion of the mold, including at least a portion of the particulate material, is dislodged from the casting. Claim 60 further recites continuing to solidify the molten metal remaining in the casting.

As noted above, there is no teaching or disclosure in any of the applied references of a process for the lost pattern casting of metals in which a fluid stream is directed at the mold when a casting in the mold is only partially solidified, at least a portion of the mold including at least a portion of the particulate material is dislodged

from the casting and the molten metal remaining in the casting continues to be solidified. As previously discussed, the only references which pertain to removing the mold and continuing to solidify molten metal remaining in a casting are the Japanese '566 and Kawaguchi references. But, these pertain to permanent molds or metal molds. Such molds are not dislodged via a fluid stream, such as is recited in claim 60. For the remaining applied references, the casting is completely solidified before the mold is removed. Therefore, it is respectfully submitted that claim 60 patentably defines over all of the references cited in connection with this application.

Dependent claims 61-71 merely further patentably define the detailed subject matter of their parent claim, or each other. As such, these claims are also believed to be in condition for allowance over the art of record.

In view of the foregoing, it is respectfully submitted that all of the pending claims are now in condition for allowance over the art of record. Such allowance is earnestly solicited.

Respectfully submitted,

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CERTIFICATE OF MAILING

Under 37 C.F.R. § 1.8, I certify that this Amendment A is being deposited with the United States Postal Service as First Class mail, addressed to: MAIL STOP AMENDMENT, Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450 on the date indicated below.

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